

SATELLITE TAGGING STRIPED BASS

BUDGET

	RFAB REQUEST	VIMS	TOTAL
Personnel			
Graves, 1.0 mon	5,460	5,460	10,920
Latour, .5 mon	3,119		3,119
GRA, Horodysky, 4 mon	9,765		9,765
Fringe, 35% salaries	3,003	1,911	4,914
Supplies - field supplies for tagging; fuel compensation for fishers	1,000		1,000
Travel - to marinas to get on vessels	250		250
Equipment - 10 satellite tags @\$4,000	40,000		40,000
Argos - access to satellite data; 10 months @\$250	2,500		2,500
TOTAL, Expenses	65,097		65,097
Facilities & Administrative Costs	6,274	8,336	14,610
TOTAL	\$71,371	\$15,707	\$87,078

Facilities & Administrative Costs calculated at 25% of direct costs. Approved rate is 45% TMDC. Difference is included as cost share contributed by VIMS.

Budget justification:

Supplies include items such as: vessel fuel to compensate cooperating fishers, field supplies for tagging activities

Travel includes: mileage and tolls to meet cooperating vessels

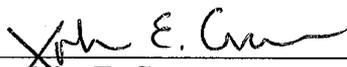
Proposal Submission to
Recreational Fishing Advisory Board
Virginia Marine Resources Commission

by

The Virginia Institute of Marine Science
College of William and Mary

**Pilot study: Application of pop-up satellite archival tags (PSATs)
to assess postrelease survival, habitat utilization and short term
movement of striped bass in Virginia's winter recreational fishery**

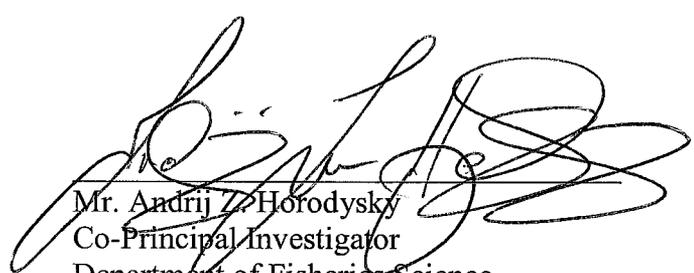
Proposed starting date: 1 January 2008
Proposed duration: 12 months



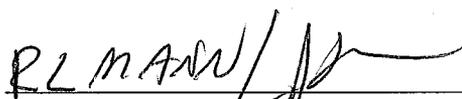
Dr. John E. Graves
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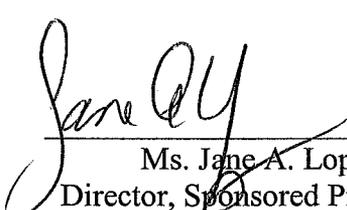
Dr. Robert J. Latour
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Background/Need

Striped bass (*Morone saxatilis*) are a highly-prized and recreationally-important species, providing over \$300 million to the US economy and over \$60 million to Virginia annually (Kirkley and Kerstetter, 1997; Richards and Rago, 1999). The Chesapeake Bay stock of striped bass is thought to be the most productive along the Atlantic coast. Tagging and genetic studies have demonstrated that Chesapeake Bay is the major source of recruits for coastal fisheries, accounting for > 90% of Atlantic coastwide landings in some years (Richards and Rago, 1999; Secor, 2000; Secor and Piccoli, 2007). Seasonal migratory patterns of this species result in the aggregation of large, predominantly female striped bass in Virginia's coastal waters during the winter months, during which time these striped bass are easily accessible to Virginia's anglers. Unfortunately, little is known about the effects of certain live bait-terminal gear (circle hooks vs J hooks) combinations on postrelease survival in this fishery, and even less is known about the short term habitat utilization and movements of large coastal migrant striped bass comprising Virginia's winter recreational fishery. This aggregation provides a unique opportunity for collaborative efforts between Virginia's scientific and recreational fishing communities to deploy high-resolution pop-up satellite archival tags (PSATs) on large striped bass.

We therefore propose a pilot project to assess the feasibility of the newer, smaller generation of high-resolution PSATs as a tool to:

- (1) investigate the effects of circle hooks and straight-shank ("J") hooks rigged with live eels on postrelease survival, and
- (2) delineate short-term habitat utilization, temperature/depth distributions, and movements of striped bass released in Chesapeake Bay's winter recreational fishery.

Life History and movements

Striped bass (*Morone saxatilis*) are an anadromous species that migrates from the ocean to freshwater rivers to spawn. This species demonstrates large plasticity in migration patterns, with sex- and age-specific movements (Secor and Piccoli, 2007). In fact, striped bass in Chesapeake Bay are considered partial migrants, with only a fraction of individuals leaving estuarine habitats for oceanic waters (Kohlenstein, 1981).

Young-of-the-year striped bass tend to remain in close proximity to their natal river system (Mansueti, 1961). As they age, striped bass extend their range first within the Bay, and then along the Atlantic coast. Age-3 fish move widely within the Bay and occasionally overwinter in North Carolina waters before returning to the Bay (Kohlenstein, 1981). Age-2 and 3 striped bass join the stock that congregates in mid-Atlantic coastal waters in the winter and migrates northward along the coast in the early spring (Kohlenstein, 1981). This coastal migrant segment of the population appears to be nearly 90% female (see Kohlenstein, 1981). Migratory striped bass of Chesapeake origin move northward along the coast in the spring, spend summer in coastal waters of the mid-Atlantic and New England states, and begin southward movements along the coast in the fall (Kohlenstein 1981). Most overwinter in more southern and coastal waters ranging from New Jersey through North Carolina (Dorazio et al., 1994). Although this qualitative pattern of movement is generally accepted, it has not been quantified. Little is known of the short-term habitat utilization, movements, and residence times of large coastal migrant striped bass that are the dominant component of the coastal winter fishery in Virginia waters.

The movements and residence times of these larger and predominantly female striped bass (age 3+) are of particular interest because they are subject to concentrated seasonal fishing pressure in Virginia waters. Informed resource management requires a quantitative understanding of movement patterns and the migratory behavior on both short and longer term scales. In particular, it

is important to understand the short term behavioral patterns of the migrating stock while in Virginia's waters and the relative contribution of the Chesapeake spawning grounds to the coastal fishery. There are indications that only a small fraction of the striped bass spawned in tributaries to the Chesapeake leave the Bay, and that the majority of the striped bass taken in northern coastal waters originate in the Bay (Kohlenstein, 1981; Secor and Piccoli, 2007). The magnitude of this contribution of Chesapeake Bay striped bass to coastwide fisheries is governed by lifetime patterns of habitat use, ontogenetic rates of emigration from Chesapeake Bay waters, and temporally and spatially varying rates of natural and fishing mortality (Dorazio et al., 1994; Secor and Piccoli, 2007). Previous tag-recapture studies have provided key insights into the current knowledge of seasonal striped bass movements (Dorazio et al., 1994), but lack high-resolution information about short-term movements and residency.

Population and Fishery

The dynamics of the Chesapeake Bay striped bass population have been strongly influenced by periods of decline due to poor environmental conditions and overfishing followed by intermittent periods of high productivity with dominant year classes (Merriman, 1941; Richards and Rago, 1999). During the 1970s, high rates of exploitation on premigratory juvenile striped bass and degraded nursery habitats presumably led to recruitment failure (Gibson, 1993; Hall et al., 1993). The decline in landings reflects the decline of the striped bass population along the Atlantic coast beginning in the mid-1970s and reaching a record low in the mid-1980s (ASMFC 2005). By the early 1980s, the production of juveniles had declined below a level necessary for replacement of the spawning stock (Goodyear et al., 1985). The Chesapeake Bay population was one of the most affected by the decline, and Maryland and Virginia placed moratoria on fishing during the late 1980s. However, a combination of reduced fishing pressure and favorable environmental conditions have led to an eight-fold increase in Atlantic coast striped bass biomass over the last 20 years (Uphoff 2003). In part, the recovery of striped bass was due to its unique life history attributes, which include high fecundity and long reproductive lifespans (Secor, 2000).

In recent years, recreational catches have increased and management regulations such as bag limits and seasonal minimum and/or maximum sizes have resulted in the release of over 90% of the striped bass caught by recreational anglers (Van Winkle et al., 1988). How many of these released fish survive despite the best intentions of recreational anglers is unclear, and previous studies addressing this question included methodological and/or habitat specific constraints that may preclude the applicability of their estimates to Chesapeake Bay striped bass. Minimum size, bag limit, and catch-and-release only fishing regulations can only be effective in achieving their intended purposes if survival is high among released fish (Muoেকে and Childress, 1994). Further, accurate stock assessments necessitate a better understanding of mortality components, including natural mortality, landings, and release mortality, and movements of these fishes.

Postrelease survival of striped bass

Recreational catches of striped bass have increased in recent years (ASMFC, 2005), and management regulations such as bag limits and seasonal minimum and/or maximum sizes have resulted in the release of over 90% of the striped bass caught by recreational anglers (Van Winkle et al., 1988). However, despite the efforts of conservation-minded catch-and-release anglers, some released fish do not survive even when handled gently and resuscitated. Hook-induced injuries and trauma caused by certain bait-terminal gear combinations (e.g. live baits and J hooks) can cause unintended injury to vital internal organs and increase the probability of mortality (Cooke and Suski, 2004; Horodysky and Graves, 2005; Prince et al. 2007). Minimum size, bag limit, and catch-and-release only fishing regulations can only be effective in achieving their intended purposes if survival

is high among released fish (Muoeke and Childress, 1994). Further, accurate stock assessments necessitate a better understanding of mortality components, including natural mortality, landings, and release mortality.

Previous studies of striped bass postrelease mortality involved fish that were caught from natural populations using various methods, transported to pens, tanks, or ponds, and subsequently observed for mortalities over varied lengths of time (Table 1 and 2: Harrell, 1988; Hysmith et al., 1993; Diodati and Richards, 1996). While these methods bear the advantage of being logistically simple and easy to control, they add the additional stress of transport and holding of study animals in unnatural conditions (Diodati and Richards, 1996). Furthermore, these studies have generally been conducted in environmental conditions very different from Chesapeake Bay (freshwater reservoirs and rivers: Harell, 1988; Hysmith et al., 1993; Wilde, 2000; manmade saltwater ponds: Diodati and Richards, 1996). Previous experimental estimates of hooking mortality cannot predict population-level mortality unless experimental conditions adequately represent those encountered in the wild and in realistic fishery encounters. Current recreational postrelease mortality estimates for striped bass range between 3-67% (Table 1). The 9% recreational postrelease mortality estimate of Diodati and Richards (1996), obtained from experiments conducted on striped bass caught on a variety of baits and lures and held in salt ponds in Massachusetts, is currently used in population assessments for the Chesapeake Bay stock (ASMFC, 2005).

There are several reasons why most of these estimates of postrelease survival may not be applicable to Virginia's recreational striped bass fishery. The additional handling and forced captivity of "released" fish in unnatural conditions in these studies creates additional stress that does not accurately mirror the release experience of striped bass in Virginia's winter fishery. Environmental variables such as temperature and salinity, as well as differences in terminal gear, bait/lure type, and size of the tackle used in these studies may not accurately represent those used in Virginia's winter fishery. Finally, the size, age, and sex distributions of striped bass previously studied are not representative of our coastal winter fishery. These deficiencies have led some authors to suggest that future experimentation with coastal migrant striped bass, particularly those including circle hooks experiments, has great potential to provide information necessary to improve management of striped bass (Millard et al., 2003).

Pop-Up Satellite Archival Tags

Developments in satellite archival tags have greatly improved scientific understanding of the behavior, movements and postrelease survival of marine vertebrates, from which in many cases it is not practical to physically recover tags to obtain data (Arnold and Dewar, 2001; Graves et al. 2002; Holland, 2003). PSATs take physical and positional measurements while attached to study animals, independently detach at predetermined times, float to the surface, and transmit data to orbiting satellites of the Argos system (Graves et al., 2002). Data are then transmitted from satellites to a ground station and to the individual researcher. Using high resolution PSATs, it is easy to determine the fate of tagged animals (Fig. 1), and resultant data reveal exciting insights into short term depth and temperature utilization (Fig 2) as well as horizontal movements (Fig 3). High-resolution PSAT tags have proved extremely useful to describe the horizontal movements and short term temperature and depth utilization of white marlin (Horodysky et al., 2007).

PSAT tags have also been used with great success to determine the effects of various terminal tackle and bait/lure combinations on survival (Graves et al., 2002; Domeier et al., 2003; Kerstetter and Graves, 2006), including a study which demonstrated highly significant differences in postrelease survival of white marlin caught on circle and J hooks rigged on natural baits (Horodysky and Graves, 2005). Circle hooks thus show great promise in substantially reducing unintended

release mortality of predatory fishes caught in recreational fisheries, and PSATs are extremely effective tools at discerning release mortality.

Most PSAT deployments to date have been on large pelagic marine vertebrates such as billfishes, tunas, sharks, and sea turtles owing to the size and mass of the tags (~ 65g). However, recent miniaturization of tag subcomponents has led to the development of a new generation of PSATs that are 33% smaller, which will extend the potential use of these tags to smaller species. Application of this technology to striped bass in Virginia waters will mark the first use of these new generation tags with coastal species.

Expected results/Benefits

Benefit of PSAT tagging of striped bass to fisheries management

This pilot study will assess the feasibility of the newer, smaller generation of high-resolution pop-up satellite archival tags (PSATs) as a tool to investigate postrelease survival, short term habitat utilization, and movements of striped bass in Virginia's coastal winter fishery. With only ten tags and two classes of hooks (straight-shank ("J") hooks and circle hooks), it is unlikely that we will reveal statistically significant differences in postrelease survival of fish caught on the different types of hooks. However, successful application of this technology to striped bass will reveal a trend, if one exists, facilitating the design of subsequent studies to identify mechanisms to reduce unintended release mortality. At present, little is known about habitat utilization or short-term movements of large striped bass that overwinter at the mouth of Chesapeake Bay, and the data from this study will provide needed information. Furthermore, the results of this study will allow us to evaluate the effectiveness of this new generation of PSATs in the estuarine/coastal environment not only for short-term deployments (1 month) but also for longer tagging periods (up to one year).

Benefit of PSAT tagging of striped bass to Virginia's recreational fishermen

Successful application of this technology to striped bass will allow Virginia's anglers to better understand the behavior and movements of large coastal migrant striped bass in the coastal winter fishery. Similar research using PSATs to evaluate the habitat utilization and movements of white marlin (Horodysky et al. 2007) continues to generate great interest in the mid-Atlantic recreational billfish community. Additionally, this research has the potential to increase awareness and interest in the use of circle hooks combined with natural baits via education and outreach of study results. In many fisheries, circle hooks have reduced unintended release mortality (Cooke and Suski, 2004). Finally, we will disseminate results of this pilot study to local Virginia fishing organizations.

Approach

Brief methodology:

The Microwave Telemetry, Inc. (Columbia, MD) PTT-100 HR X Tag will be used in our study. This tag is slightly buoyant, and weighs 40 grams in air. The body of the tag contains a lithium composite battery, a microprocessor, a pressure sensor, a temperature gauge, and a transmitter, all housed within a black resin-filled carbon fiber tube. Flotation is provided by a spherical resin bulb embedded with buoyant glass beads. This tag model is programmed to record and archive a continuous series of temperature, light, and pressure (depth) measurements, and can withstand pressure equivalent to a depth of 3000 m. Tags will be programmed to disengage after 30 days and will record measurements approximately every two minutes.

PSATs will be attached to striped bass by an assembly composed of 16 cm of 400-pound test Momoi® brand (Momoi Fishing Co., Ako City, Japan) monofilament fishing line attached to a large hydroscopic, surgical grade nylon intramuscular tag anchor according to the method of Graves et al. (2002). Anchors will be implanted with 5-cm stainless steel applicators attached to 0.3-m, 1-m, or 2-m tagging poles (the length of the tagging pole varied depending on the distance from a boat's gunwhales to the water) and will be inserted approximately 5 cm deep into an area about 6 cm posterior to the origin of the dorsal fin and 5 cm ventral to the base of the dorsal fin (Fig. 1). In this region, the nylon anchor has an opportunity to pass through and potentially interlock with pterygiophores supporting the dorsal fin well above the coelomic cavity containing visceral organs (Graves et al., 2002). When possible, a conventional tag will also be implanted posterior to the PSAT.

Tagging operations will be conducted in the area around Cape Charles where a significant recreational fishery for "trophy" striped bass has developed over the past few years. We have secured the cooperation of a skilled captain and angler familiar with this fishery to provide a platform for our operations (see attached letter). Striped bass will be caught on 30 lb class sportfishing tackle with four foot leaders of 80lb test line, and fought in a manner consistent with typical recreational fishing practice. Five tags will be deployed on striped bass caught on circle hooks, and five tags will be deployed on striped bass caught on J hooks, using the tag application procedure presented for white marlin in Horodysky and Graves (2005). All circle and straight-shank ("J") hooks will be rigged with live American eels (*Anguilla rostrata*) as bait with the hook exiting the dorsal surface of the head of the eel. Size 8/0 Owner straight-shank ("J") hooks and size 8/0 Owner circle hooks will be used (hooks of a smaller size will be used if large eels are not available as bait). The rigging designations and fishing techniques unique to each hook type were maintained in our study to reflect the usual application of circle and straight-shank ("J") hooks in the winter striped bass recreational fishery off Virginia.

Estimated cost

This proposal covers the cost of this one year pilot project. We expect the cost of this study to be \$81,618, of which we are requesting \$71,347 from VMRC.

Requested funds would cover:

- (1) the partial salary costs of a VIMS graduate student and faculty to conduct this work,
- (2) a tag budget of \$40,000 to cover the costs of 10 PSATs (\$4,000 each) and \$2,500 to cover the costs of the Argos satellite time to download data from transmitting tags
- (3) a \$1000 supply budget to cover tagging and analytical supplies as well as fuel cost subsidy for recreational captains who allow us to work on their vessels.
- (4) a travel budget of \$250 to cover transportation to marinas for field operations and to Virginia fishing club meetings for outreach presentations
- (5) VIMS Facilities & Administrative Costs at the VMRC reduced rate of 25% (the standard institutional rate is 45%). VIMS will provide the difference of the reduced rate versus the institutional rate as match funds.

References

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Table 1. Summary of published postrelease survival experiments using J and treble hooks conducted on recreationally released striped bass.

<u>Authors</u>	<u>Region</u>	<u>Season</u>	<u>Hook type</u>	<u>Bait-lure type</u>	<u>Postrelease environment</u>	<u>Release mortality</u>
Harell 1988	FW	Winter, summer	J	Live bait, lures	Unclear	15.6% (lures), 30.7% (bait)
Hysmith et al. 1993	FW: Lake Texoma, TX	Winter, summer	J	Live bait, lures	Unclear	38%
Diodati and Richards 1996	SW: Massachussets	Summer	J	Live bait, jigs, plugs	2 hectacre saltwater pond	3-26%; mean 9%
Nelson 1998	FW: Roanoke River, NC	Spring	J and treble	Live baits, jigs, plugs w/ treble hooks	2000 L fiberglass tanks	6-27%: mean 6.3%
Bettoli and Osborne 1998	FW: Tims Ford Resevior, TN	Winter, summer	J and treble	Live baits, jigs, plugs	Tagged and released in Tims Ford Reservoir	14-67%
Millard et al. 2003	FW: Hudson Bay	Spring	J	Varied and unexplained	2.5x2.3 m pens	28-31%

Table 2. Technical reports comparing the effects of circle and J-hooks on striped bass postrelease survival

<u>Authors</u>	<u>Region</u>	<u>Season</u>	<u>Hook type</u>	<u>Release mortality</u>
Caruso 2000	Massachussets	summer	J C	J: 15.5%, C: 3% (bait)
Lukacovic 2000	Maryland	summer	J C	J: 9.1% C: 0.8%

Figure 1: Schematic representation of depth and temperature tracks recorded by PSAT tags deployed on a surviving (a: MA12) and moribund (b: MA01) white marlin (from Horodysky and Graves, 2005). Filled symbols correspond to measurements taken while tags were attached to animals, hollow symbols refer to measurements taken after pop-up while tags were transmitting data to Argos satellites. Grey bars denote periods of local night. Results demonstrate the ease with which mortalities can be identified from surviving fish.

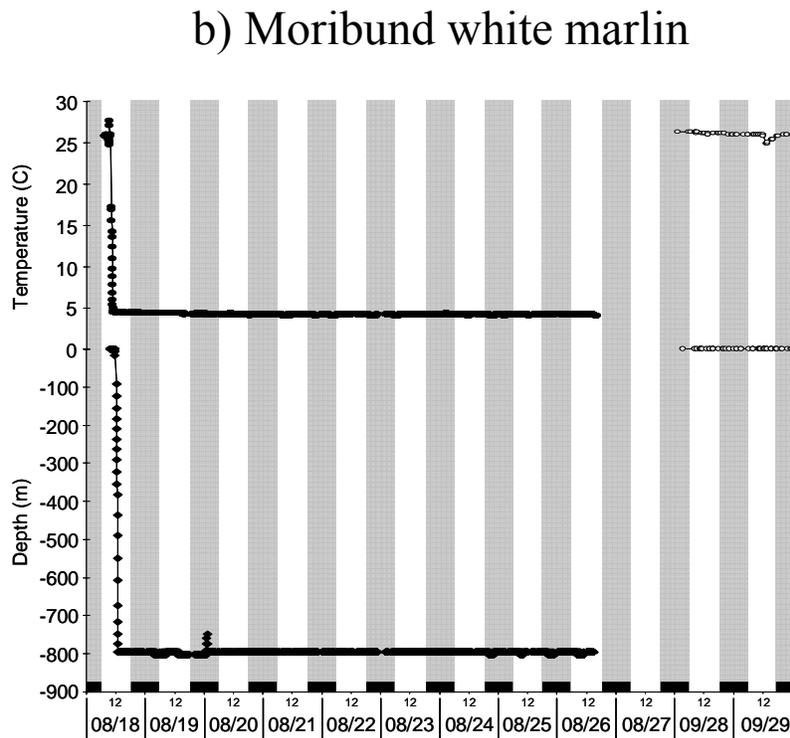
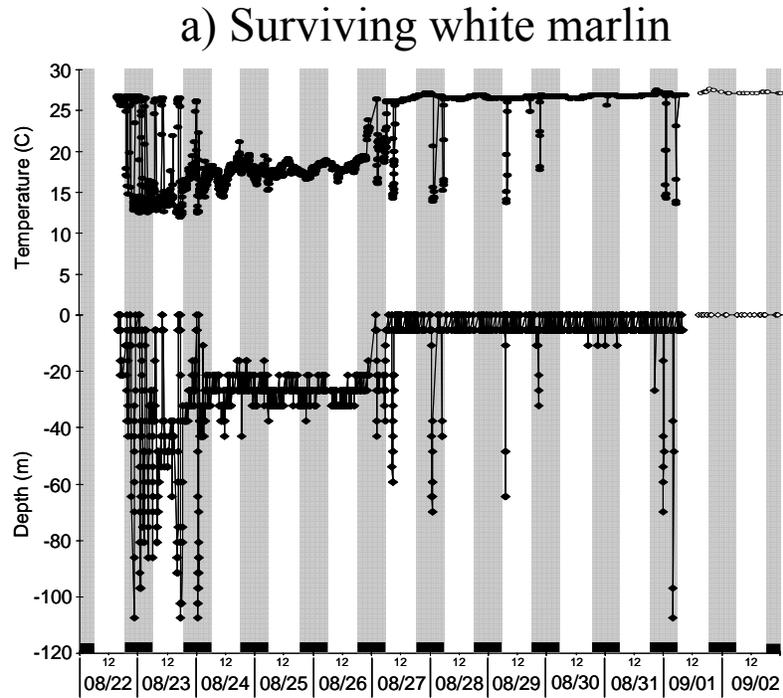


Figure 2: Representative temperature-depth dive profiles of six white marlin tagged with PSATs. Full 5-day and 10-day time series of vertical movements are presented at the left. Insets are 24hr tracks superimposed on the thermal structure of the surrounding water column reconstructed from temperature data recorded by each PSAT. White marlin EC02-12 (A) and EC02-10 (B) were tagged offshore of the U.S. east coast. Fish NC03-02 (C), NC04-01 (D), and NC02-02 (E) were tagged in the northern Caribbean, and VZ03-10 (F) was tagged offshore of La Guaira Bank, Venezuela. Data from Horodysky et al (2007).

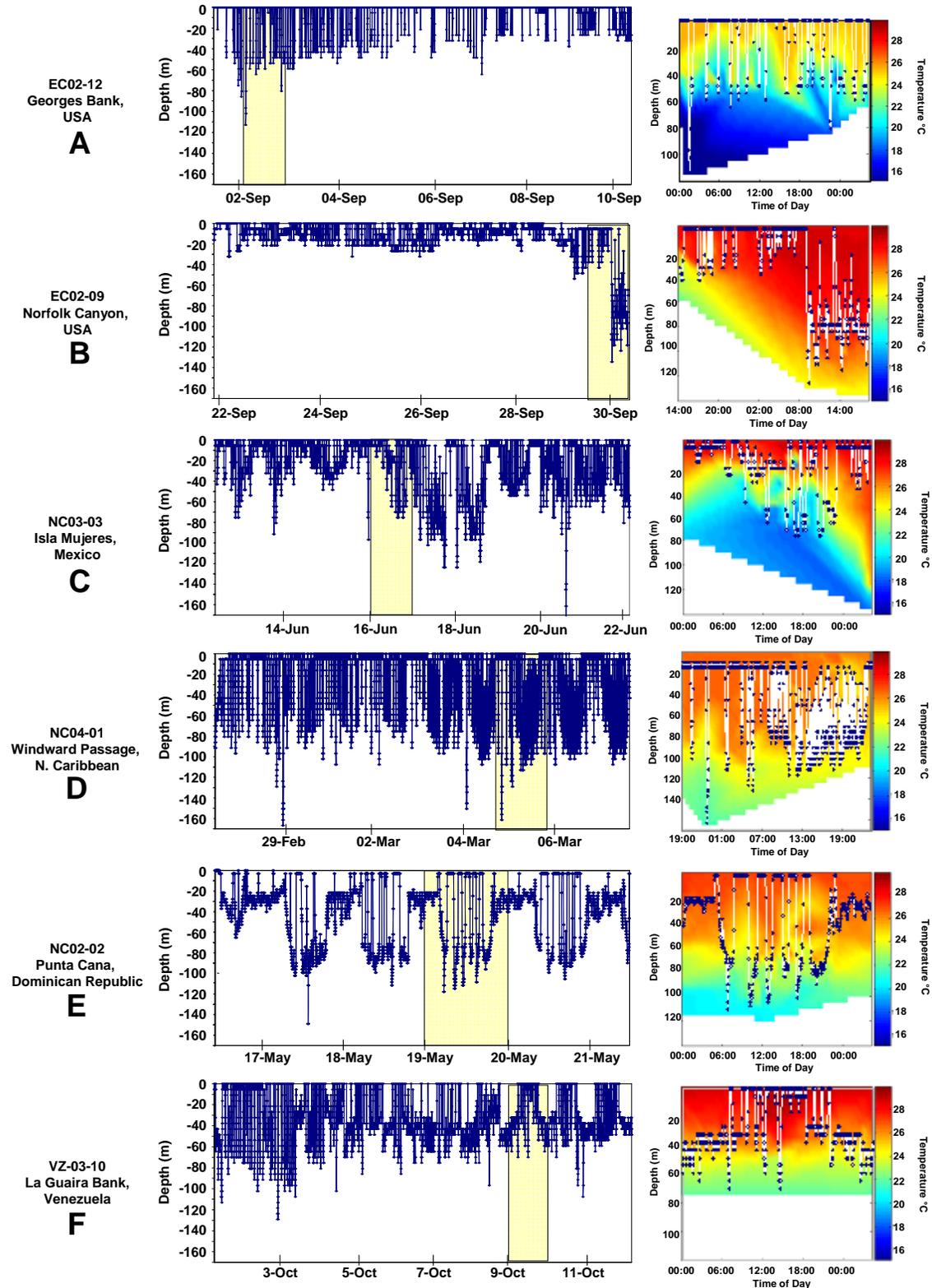
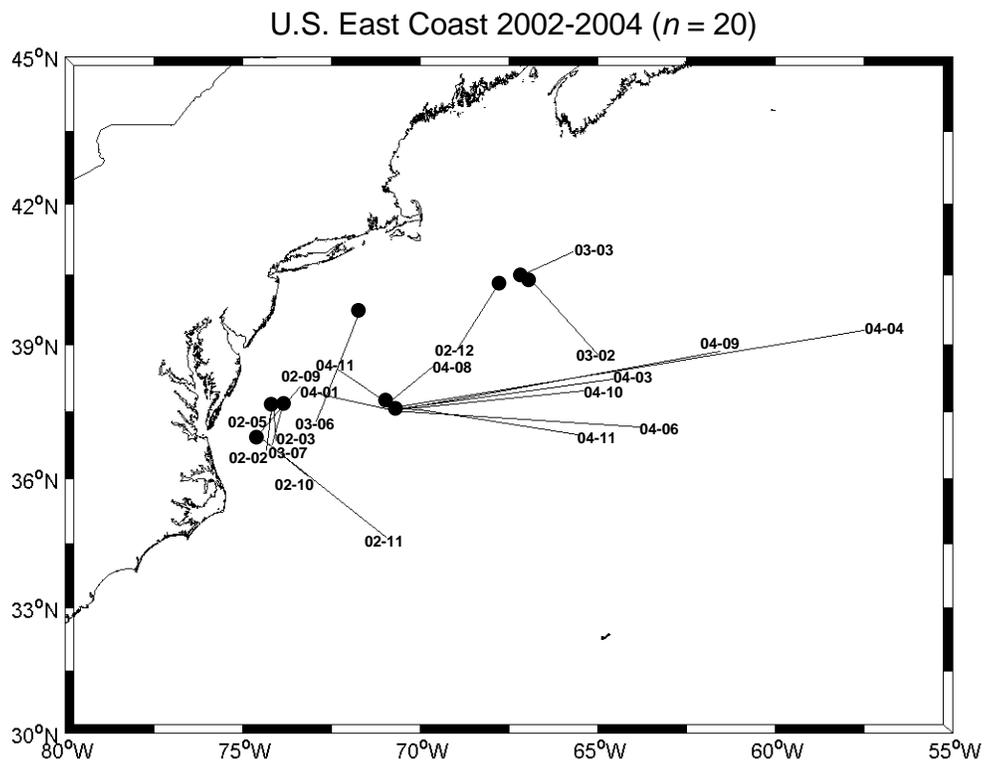


Figure 3: Minimum straight line displacements of white marlin tagged with PSATs offshore of the U.S. East Coast between 2002-2004 ($n = 20$) demonstrating horizontal movements of fish. Black dots denote tagging locations, and text labels denote first point of contact with transmitting tag after release from the fish. Data from Horodysky et al. (2007).



John Graves
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Gloucester Point, VA 23062

Dear Dr. Graves:

I am happy to learn that you are applying for funding from the Recreational Fishing Advisory Board to support a pilot study applying pop-up satellite archival tags to striped bass in the winter fishery. Like you, I would like to know if there is a big difference in the post-release survival of striped bass caught on circle hooks and J hooks. I am more than willing to assist you with the study, and that includes making my boat "Healthy Grin" available to you as a tagging platform. Needless to say, I can provide all of the bait, tackle, and avid anglers to get the fish to tag. As you have attached satellite tags to white marlin from my boat in the past, I am sure we can do the same for striped bass.

Sincerely,

A handwritten signature in cursive script, appearing to read "Ken Neill, III".

Dr. Ken Neill, III